GC12-FibreOptic-30, updated on 21 May 2024
https://doi.org/10.5194/egusphere-gc12-fibreoptic-30
Galileo conference: Fibre Optic Sensing in Geosciences

Use of distributed fibre sensing in marine geodesy

Shane Murphy[1], Mimmo Palano[2], Pierre Garreau[3], Marco Terzariol[1], Stéphan Ker[1], Giuseppe Cappelli[1,4], Lionel Quetel[4], Giorgio Riccobene[5], Salvo Aurnia[5], Salvo Viola[5], Sara Pulvirenti[5], and Marc-Andre Gutscher[1]

[1]Geo-Ocean, UMR6538 Univ Brest, CNRS, Ifremer, Plouzane, France
[2]Dipartimento di Scienze della Terra e del Mare, Università degli Studi di Palermo, Palermo, Italy
[3]LOPS, Ifremer, Plouzane, France
[4]IDIL Fiber optics, Lannion, France
[5]INFN - LNS, Catania, Italy

With 70% of the earth underwater, seafloor geodesy provides a vital means of measuring tectonic deformation in a zone where terrestrial geodesy cannot reach. The expense of placing, maintaining and recovering instruments and data from seafloor sensors makes their widespread use prohibitive. Distributed fibre sensing techniques offer the opportunity to measure deformation along the seafloor at unprecedented spatial resolution and at a high sensitivity. An added advantage of this technology is that it can utilise pre-existing infrastructure such as telecommunication cables or cabled scientific seafloor observatories converting them into multi-node marine sensors. While much attention has focused on the application of DAS in seismology, the use of other distributed sensing techniques in the geosciences remains under studied.

Brillouin Optical Time Domain Reflectometry (BOTDR) provides a means of measuring relative changes in longitudinal strain and temperature on the order of a few meters with a sensitivity of micro-strain making it an ideal tool for marine geodesy. We will present a theoretical study investigating how it may be applied and what are challenges of using this technique. Using a dislocation model in linearly elastic half space media we demonstrate that the relationship between cable and fault geometry is a critical feature that needs to be accounted for when designing a geodetic survey. For example, in the case of a strike slip fault a cable at a 45° angle relative to the fault strike will be more sensitive compared to a cable traversing the same fault at 90° . We will also demonstrate what information on imaging tectonic slip could provide by cables through the calculation of resolution kernels for a variety of different faults.

Finally, we discuss some of the challenges to the use of BOTDR in marine environments. Using BOTDR data collected continuously over a period of 1.5 years starting in May 2021 on the INFN-LNS cable which extends offshore Catania, we demonstrate the effect seasonal water temperature plays on strain readings. We also discuss observations from laboratory geotechnical experiments that demonstrate the importance of accounting for phenomena such as cable buckling and coupling.